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NASA CR-54958--Quarterly Progress Report for the Period
November 23, 1965 through February 28,
1966 (GA-7070)

NASA CR-72032--Quarterly Progress Report for the Period
March 1, 1966 through May 31, 1966
(GA-7250)

NASA CR-72132--Quarterly Progress Report for the Period
June 1, 1966 through August 31, 1966
(GA-7473)

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DIRECT CONVERSION PROJECT MANAGER

R. W. Pidd

PRINCIPAL INVESTIGATOR Contract NAS 3-6471

L. Yang

Work done by

Members of the Direct Conversion Project

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INTRODUCTION

This report describes the work carried out under Contract NAS 3-6471 during the period September 1, 1966 to November 30, 1966 on the following two subjects:

1. Fabrication of converters LC-7, 8, and 9.
2. Irradiation studies of thermionic materials.

Studies of other subjects of nuclear thermionic interest are being pursued under Contract NAS 3-8504 concurrently with these two tasks.

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PART I. FABRICATION OF CONVERTERS LC-7, -8 AND -9

(H. Horner)

1.1. LC-7 FABRICATION

Diode assembly and final de-gassing were completed during this quarter. Excessive outgassing of the partial pressure sensing element, cell exhaust tubulation and VacIon pump was experienced during the de-gassing operation. In addition, another partial pressure sensing element plus a 15 liter per second VacIon pump were added to the de-gassing assembly after the original partial pressure sensing element failed. These added components replaced the original VacIon pump and could be isolated from the converter by a high vacuum valve for bakeout at 250°C prior to opening to the converter. Cell pinch-off was accomplished after the de-gassing operation and vacuum emission measurements. Since vacuum emission measurements indicated that the cesium vial had released cesium during the last stage of the post assembly outgassing treatment, steps were taken to remove any large amount of cesium that might have been present in the pinch-off area. To remove the cesium from the pinch-off area, the pinch-off was heated to ~ 500°C while the collector temperature was maintained near room temperature by cooling the collector heat sink air tubes with water. After heat treatment of the pinch-off area, the cesium vial temperature was lowered by chilling with dry ice, and the vial was opened by compression of the cesium lead tube to allow residual gas analyses of cesium vial contaminants. The cell was pinched-off, the pinch-off welded and the cell delivered to the test group for initiation of test installation.

1.2. LC-8 FABRICATION

An emitter was prepared to accept the fuel slabs and outgassed at 2000°C for 50 hours.

Assembly of the collector heat sink (the only major subassembly remaining to be completed other than the emitter) was brought successfully

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through the heater wire brazing steps. The heater wires failed once during the brazing cycle and had to be replaced. Assembly of this unit continues.

A 85% dense 90UC-10ZrC fuel pellet containing 3 mole % excess carbon was prepared, and fuel slabs were machined from this pellet, outgassed and analyzed. The analytical data, however, showed these slabs to be 2 mole % deficient in carbon. Apparently carbon was lost because of contaminations introduced during the handling and machining these highly porous fuel slabs of large surface to volume ratio.

Since in the testing to determine any fuel effects on out-of-pile converter performance the use of porous carbide fuel bodies is not mandatory as in the case of in-pile testing where porous carbide fuel bodies are needed for minimizing fuel swelling, it was decided that high density 90UC-10ZrC fuel slabs (> 90% dense) should be used in order to minimize contaminations due to handling and machining while not compromising the object of the experiment. In addition, both post-operational examination of the LC-1 fuel slabs and diffusion-emission studies indicated that about a few wt% of tungsten was taken into solution in the carbide fuel from the tungsten cladding during these long-term tests (1000 - 7000 hours). It was therefore decided that enough tungsten should be added to the carbide fuel in order to satisfy its solubility for tungsten before the initiation of the converter testing.

Fabrication of a high density 90UC-10ZrC fuel body containing ~ 4 wt% tungsten and 3-5 mole % excess carbon has been initiated.

1.3. LC-9 FABRICATION

Emitter Assembly

The chloride tungsten emitter was machined, outgassed at 2000°C for 50 hours and then characterized by x-ray diffraction to determine its preferred orientation. The surface showed evidence of being preferentially {110} oriented, although the cylindrical configuration of the surface did not allow an estimation of the degree of {110} orientation. After brazing to the tantalum transition piece and machining to dimension, the emitter was sent to the test group for work function and temperature profile measurements.

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Cell Assembly

Final cell assembly operations were initiated by welding an insulator to the emitter structure and fitting the emitter subassembly to the collector. The cesium reservoir was then welded to the collector and leak checked, and the cell was set up for final assembly. Previous experience (see Section 1.1) in assembling LC-7 indicated that the bake-out of the partial pressure sensing element, the connecting tubulation and valves, and the VacIon cell exhaust pump should be conducted more thoroughly prior to cell assembly than that for LC-7. The plumbing was also rearranged so that the cell could be isolated from the partial pressure sensing element and pump during the cell final outgassing cycle to allow additional baking of the partial pressure sensing element if this is needed. Two 15 l/sec pumps were included in the cell exhaust plumbing.

The cell assembly cycle was initiated by a thorough baking of the partial pressure sensing element, the isolation valves and the VacIon pumps at 300°C for 24 hours. At the end of this bake-out, the cell exhaust tubulation and pumps were cooled to 150°C where they remained for the cell electrode outgassing steps. Assembly brazing of the collector subassembly to the emitter subassembly was accomplished without incident. The cell was delivered to the test group for final de-gassing and pinch-off.

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PART II. PLUM BROOK IRRADIATION STUDIES

(J. Sleight, J. Ream, W. Godsin)

The conceptual design of two different methods for positioning the irradiation capsules in the V-tube were completed during this period. One method was similar to the one previously built and utilized two linear ball bushings and one moving shaft directly coupled to a hydraulic cylinder. This concept was presented to NASA-Lewis with reservations on its maintenance problems. An alternate concept was also presented and has been selected as the method to use. The concept is shown in the layout drawings of Figs. 2.1 and 2.2. The positioning is accomplished by a mechanically driven double-ended pendulum with the drive motor and gearing outside the reactor pressure vessel.

Conceptual design of the new irradiation capsule was also completed and presented to NASA-Lewis. The design as shown in Fig. 2.3 includes a replaceable fuel thermocouple, a device to measure gamma heat, low temperature thermocouples for deducing fuel temperature in case of failure of the fuel thermocouple, and methods to determine the total heat generated. Analysis of the various influence factors on fuel temperature and gamma heating was submitted along with the conceptual design.

Review of the capsule-positioning mechanism and capsule conceptual designs is currently under way at NASA Lewis Research Center and at Plum Brook.

A series of tests to determine the long term stability of the emittance of oxidized Inconel was initiated. Samples were prepared for emittance measurements prior to encapsulation and aging at 600°C for 1000 hours in purified neon gas, in conformity with the requirements on temperature and nature of gaseous environment for the Inconel primary confinement in the capsule design.

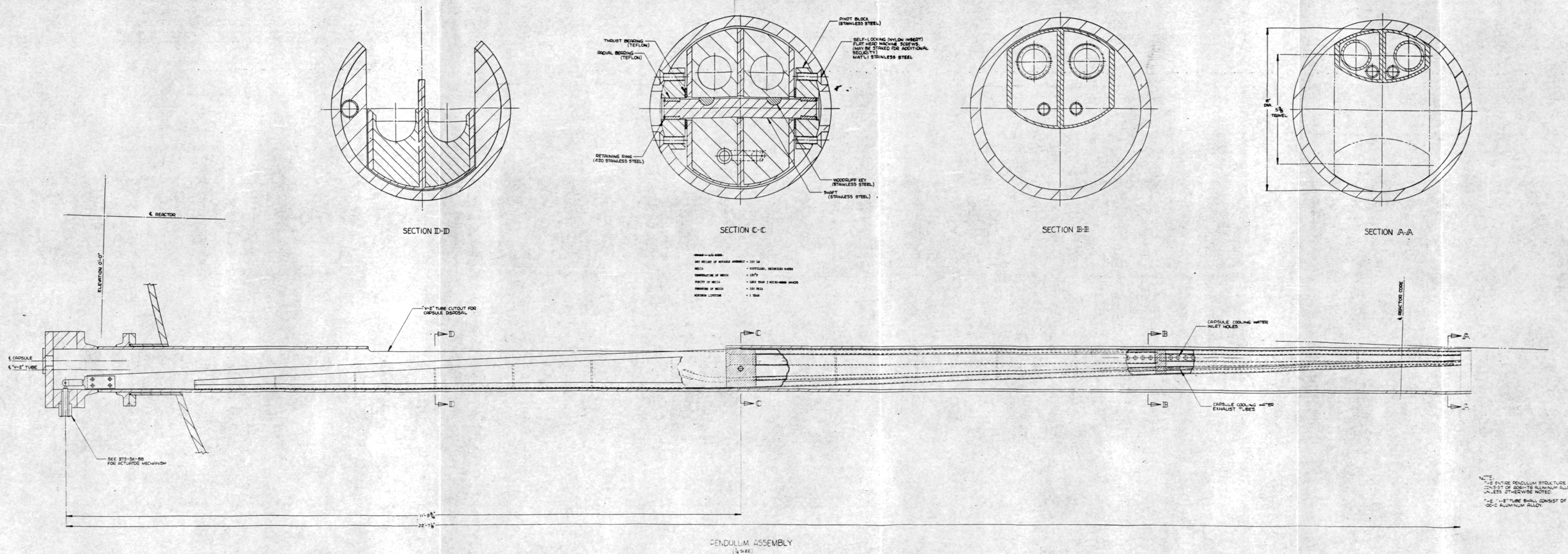


Fig. 2.1--Conceptual pendulum assembly for capsule positioning in V-tube

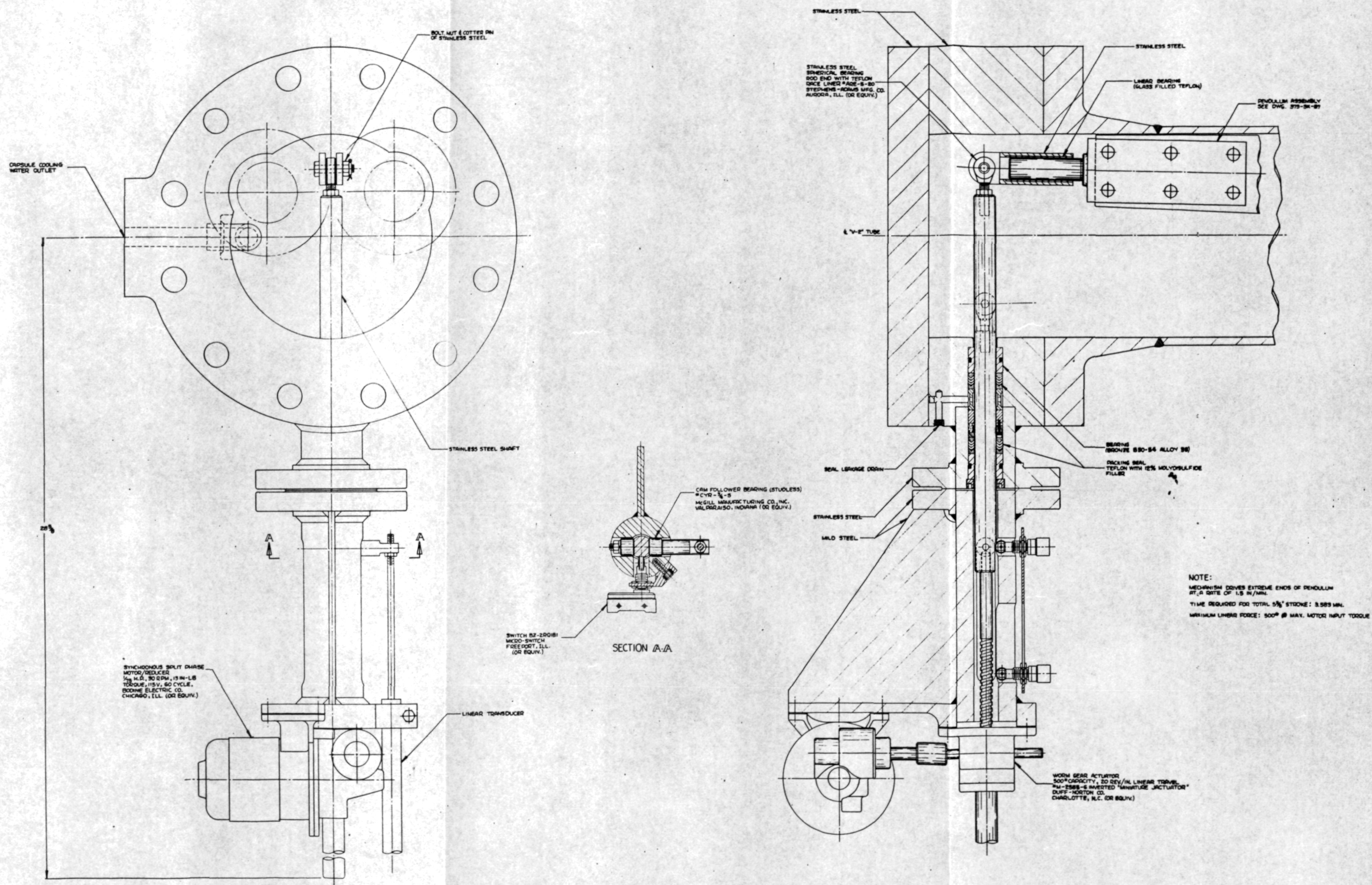


Fig. 2.2--Conceptual actuator mechanism for the pendulum capsule positioning mechanism

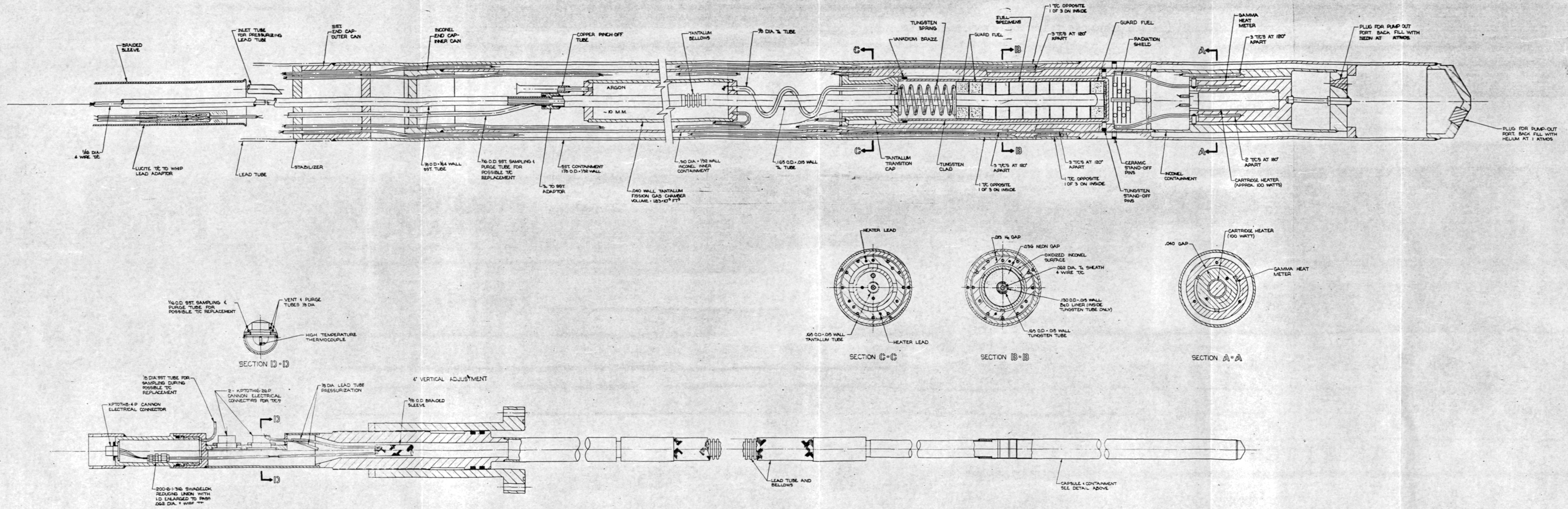


Fig. 2.3--Conceptual design for Plum Brook irradiation capsule